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SOM BASED COUNT DOWN TIME DISSEMINATION SYSTEM ALONG WITH QT BASED COUNT DOWN TIME READER APPLICATION OVER ETHERNET

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ABSTRACT

This paper describes the need and function of "SOM based Count Down Time dissemination system along with QT based Count down Time reader application over Ethernet". In Flight Test Center (FTC), single Time platform is very much needed to carry out the activities in organized way and synchronization is required among the tracking instruments deployed. Previously Time codes were transmitted to various sites through serial communication and received by TCR (Time Code Reader). As the number of tracking sites at FTC are increasing day by day, it becomes cost in-effective as well as complex to distribute Time to remote sites serially. To avoid this limitation, the current SOM based low cost Time distribution system was conceptualized, developed and implemented. The serial output of previous system is fed to SOM based system, where it is processed and outputted in Ethernet port, which makes it easier to distribute time to the remote sites. In remote sites, a GUI based Time Code Reader application receive and display both Accumulated Time of the Day (ATD) and Count Down Time (CDT) over Ethernet network. This application has ability to display multiple CDTs of multiple missions, which makes it possible to test multiple flight vehicles in the same time in future.

KEYWORDS: Serial Communication, Ethernet Communication, SOM Based System

INTRODUCTION

A newly developed Unmanned Aerial Vehicle (UAV) needs rigorous testing to satisfy all expected performance. When testing the flight dynamically, lots of uncertainties regarding the flight performance appear. Hence a Flight Test Center (FTC) is needed for this. Time is very much needed in Flight Testing Center (FTC) because a number of tracking instruments are deployed here. To maintain synchronization among different events during the test, all sites should get the same Time. Generally two types of Time are used i.e. ATD (Accumulated Time of the Day) and CDT (Count Down Time) are used in real-time flight scenario at all remote sites to maintain synchronization among all events as well as operation of tracking instruments [1].Timing Distribution Unit (TDU) involves in generation and dissemination of Time signal to different remote sites during real-time. Time is generated by a program Clock and then fed to CTDU (Central Time code Distribution Unit). From CTDU, Time is sent to various remote sites through serial cable as the output of CTDU is serial. At remote sites, Time is displayed through TCR (Time Code Reader). Previously Time codes were disseminated to various sites through serial communication and received by TCR (Time Code Reader). As the number of tracking sites at FTC are increasing day by day, it becomes cost in-effective as well as complex to distribute Time to remote sites serially. To avoid this limitation, the current SOM based low cost system was visualized, developed and implemented. The serial output of CTDU is fed to SOM based system, where it is processed and outputted in Ethernet port.

SYSTEM CONFIGURATION

Time code is generated at Program Clock in IRIG-B format. This IRIG-B Time is fed to CTDU. CTDU in turn makes this Time code available in multiple ports both in IRIG-B and ASCII format to distribute to remote sites. This SOM based system is fed with serial ASCII signal which gives the output through Ethernet port. The Time code is multicasted through Ethernet network to different sites. Multicast client at remote sites is a GUI based Time Code Reader application, where Multicast Receive Program runs. Multiple servers are also kept for redundancy and multiple CDT can be transmit and display for simultaneous test of multiple flight vehicle in future. The ATD time transmitted and displayed here is the GPS time synchronized to NTP server. Figure 1 depicts the typical system configuration.

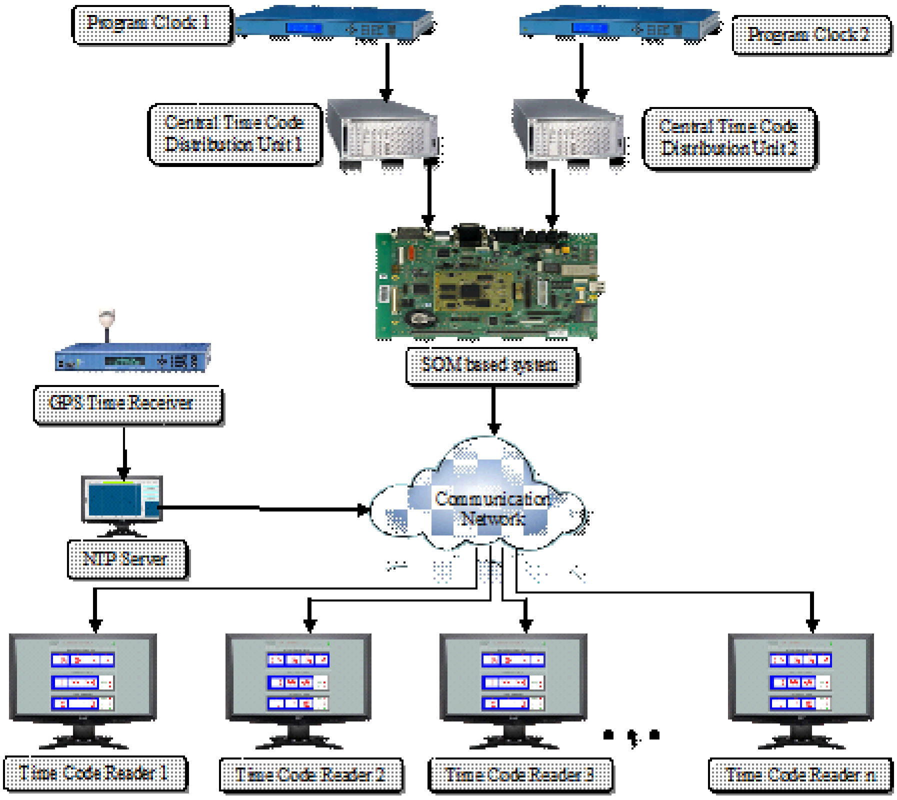


Figure 1: System Configuration

LITERATURE SURVEY

Serial Communication: In its specification primarily four parameters are mainly concerned: the baud rate of the transmission, the number of data bits encoding a character, the sense of the optional parity bit, and the number of stop bits. Each transmitted character is packaged in a character frame that consists of a single start bit followed by the data bits, the optional parity bit, and the stop bit or bits [1][2][3].

Ethernet Communication: Ethernet is the most popular LAN technology in the world. It is an easy, relatively inexpensive way to provide high-performance networking to all different types of computer equipment. This SOM based system uses IEEE 802.3 frame [4][5][6].

SYSTEM IMPLEMENTATION

Hardware Block Diagram of SOM System: SOM based system basically consists of an ARM processor based board of 220 MIPS at 200 MHz, 64 MB Physical memory, 32 MB Flash memory, One debug serial port, Two serial

ports- Serial port 1 & Serial port 2 and an Ethernet port with speed support of 100 Mbps. Debug port is nothing but the console port. The user can see the booting of ARM processor through this port. From this port user can give input to the processor. This is solely used for console purposes only. This port is at RS232 Level. A Battery is present on this, which provides back up power when external supply is interrupted. Real Time Clock (RTC) chip is also available for future improvement. The hardware block diagram of SOM based system is shown in figure 2.

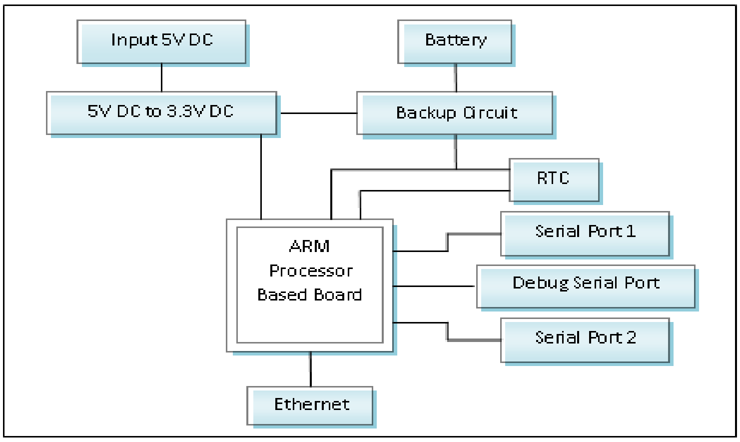
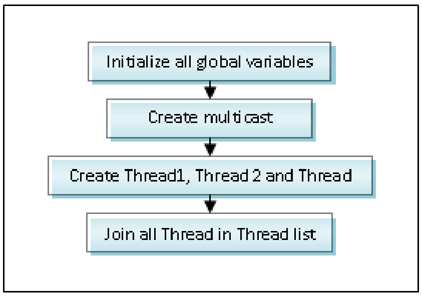


Figure 2: Hardware Block Diagram of SOM System

Multicast server Implementation: The multicast server is implemented using three threads i.e. Thread 1, Thread 2, Thread 3. Initially all the global variables are initialized. Then the multicast socket is created. After that all three threads are created for respective work, which has shown in figure 3 [5][6].

Thread 1 and Thread 2 are used to read data from two servers and store data in Buffer 1 and Buffer 2 respectively. Both of the threads check for data in UART Buffer repeatedly. If data present in UART BUFFER is true then it stores the data in respective thread Buffer and flushes the UART Buffer. Otherwise it flushes the UART Buffer, which has shown in figure 4 [5].



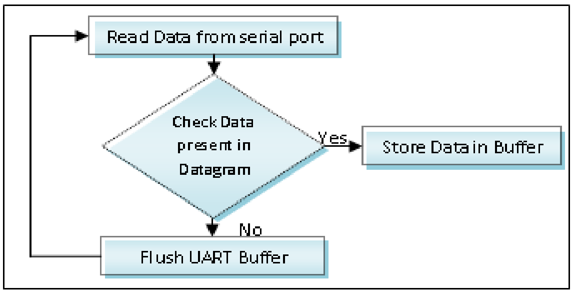


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Figure 3: Creation and Joining of Threads in Thread List

Figure 4: Threads (Thread 1, Thread 2) Checking UART Buffer

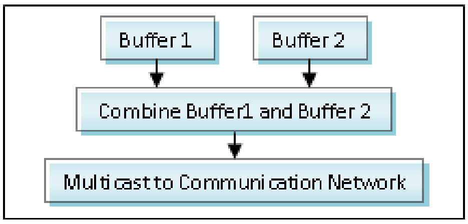

Figure 5: Multicast of Packets of Both Buffers by Thread 3

Thread 3 combines the content of Buffer 1 and Buffer 2 and multicast the combined packet into the communication network, which is shown in figure 5. TCR receives the combined packet by respective multicast group

thread and display on the GUI.

Client Side System Implementation

The client side GUI application is implemented using C programming in QT environment. It uses two threads (Thread 1 and Thread 2) for redundant purpose. Thread 1 is associated with server1 and Thread2 is associated with server2. Both the servers send the same data for redundancy. Thread1 checks the availability of data on the datagram repeatedly.

If the data is present on the datagram then it makes the flag zero and sends the data to the GUI for display. Thread 2 increments the flag each time, read the data on datagram and checks the value of flag. If the value of the flag is greater than one then it sends the data on to the GUI for display if data is present.

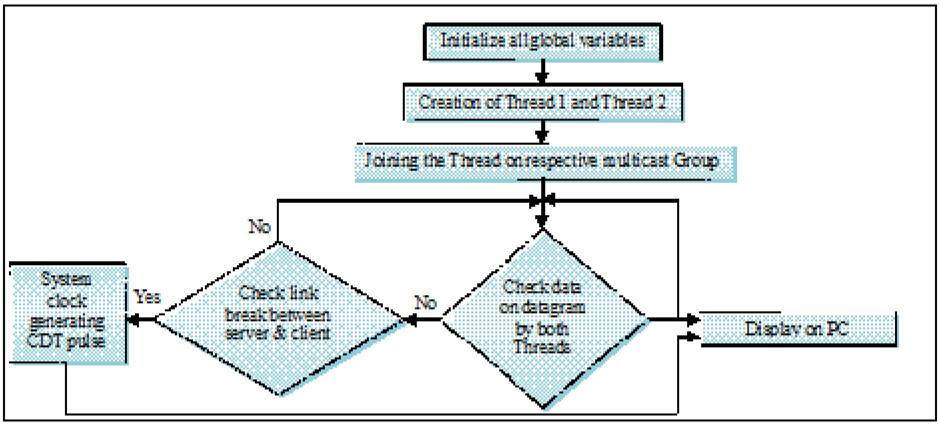

Figure 6: Client Side System Implementation

Otherwise it will check the link between server and client. This application is also incorporated with system clock, which helps to generate real-time CDT when links break occurs between server and client. The client side system implementation has shown in figure 6.

IMPORTANT FEATURES

- By implementation of this SOM based system, the existing Ethernet network has been used to distribute time. Therefore no extra cost was incurred for network implementation.
- Redundancy feature has been taken care of, in server and client side both in hardware as well as software level.
- RTC helps to maintain uninterrupted CDT display at client side, when links fails between server and client.
- This system also supports the network redundancy.
- It has low maintenance cost and it is more reliable than earlier serial transmission system.
- It supports multiple flight vehicles testing simultaneously by sending multiple CDT to different remote sites.

RESULTS AND OBSERVATION

Main Display: Figure 7 shows the time display on GUI Multi target Time Display application. It displays two types of Times. I.e. ATD and CDT. ATD Time is displayed in Day of the year, Hour, Minute and Second format. CDT is displyed in Hour, Minute and Second format in three modes. I.e. Hold, Down, Up. In HOLD mode, the same time is transmitted to all remote sites. In Down mode, counting Down time is transmitted to all sites and in Up mode, counting up time is transmitted to all sites starting counting from zero. Down mode is used before launch of the UAV and UP mode

used after launch of the UAV. It has observed that the Time on the server (Program Clock) and the TCR are same

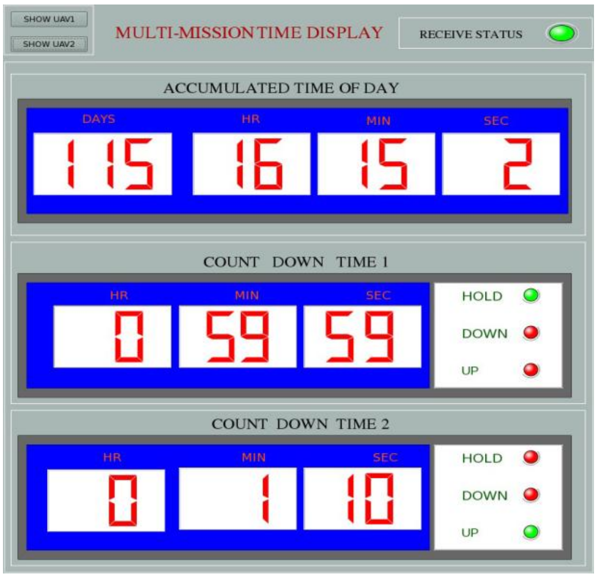

Figure 7: Time Code Reader Display Displaying Same Time as Server

Latency Calculation: The latency sources are generally duplicated for every switch that an Ethernet frame must traverse on its journey from source to destination. The general calculation for worst case latency in a switched Ethernet network is as follows [7].

$L_{Total}= [L_{SF}+L_{SW}+L_{WL}+L_{Q}]*N_{SWITCHES}$

Where, L_{Total} = Overall latency

L_{SF} =Store and Forward Latency

L_{SW} = Switch fabric Latency

L_{WL} = Wire Length Latency

L_{Q} = Queuing Latency

In this application, less than 50 bytes of information is transmitted. Store and forward latency is 7.3 micro second, switch fabric latency is 5.2 micro second, queuing latency for 25% loaded network is 30 micro second. For 20 km long optical fiber, wire length latency is 100 micro second [6]. So, for a single switch overall latency is 142.5 micro second. But we have observed the latency is 151 micro second for the deployed system in real-time. This much latency is well accepted in FTC application.

CONCLUSIONS

The application has been tested and validated during various flight tests in the recent past. The system performed satisfactorily for real time dissemination of time to various remote sites and display. Moreover count down time can be transmitted through this system to various remote sites. The system is being evaluated currently for dissemination of CDT over Wi Fi wireless network.

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